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Preparing patients for travel to high altitude:

advice on travel health and chemoprophylaxis

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INTRODUCTION

Travel to altitudes above 2500 m is a popular recreational activity that presents a potential risk of high-altitude illness. Acute mountain sickness (AMS), for example, affects up to three-quarters of trekkers attempting to climb Mount Kilimanjaro in Tanzania, East Africa (5895 m). GPs should be able to provide practical advice on prevention of high-altitude illness.[1] Travellers, especially those travelling in organised groups, may not allow adequate time for acclimatisation owing to pressurised itineraries, and administering chemoprophylaxis to accelerate this physiological response to hypobaric hypoxia may be indicated in some cases. This article summarises current recommendations in relation to high-altitude illness, its prevention, and the specific precautions that should be followed by patients with pre-existing chronic illnesses.

HIGH-ALTITUDE ILLNESS

Classification and diagnosis

The single most important risk factor for the development of high-altitude illness is rate of ascent. There is significant heterogeneity with respect to the rate at which individuals can ascend without developing altitude illness. There is no reliable means to predict at sea level which travellers are more likely to be affected, and measuring capillary oxygen saturation with a pulse oximeter during ascent does not predict the development of AMS.[2] All travellers to high-altitude environments should be able to recognise the symptoms of high-altitude illness. According to the Lake Louise consensus definition,[3] AMS is characterised by the presence of a non-specific headache and at least one of the following symptoms: lack of appetite, nausea, vomiting, fatigue, disturbed sleep, or dizziness, and occurring 6–12 hours after arrival at altitude. The differential diagnosis of headache at altitude is broad, but the first of the Himalayan Rescue Association's four 'Golden Rules' advocate that, if one is ill at altitude, the symptoms are due to altitude illness until proven otherwise.[2]

High-altitude cerebral edema (HACE) and high-altitude pulmonary edema (HAPE) are much less common than AMS but more likely to be fatal, especially as altitude increases. HACE can be distinguished from AMS by symptoms of encephalopathy such as ataxia and confusion. In many cases, HACE is preceded by AMS, but it may also occur *de novo*. In patients with HAPE, a non-cardiogenic pulmonary hypertension causes patchy alveolar edema, leading to dyspnoea at rest, cough, and fatigue. Patients may be tachycardic, tachypnoeic, and febrile with crackles on auscultation, especially in the right middle lobe. Periodic breathing, with its periods of apnoea, may be alarming but it is not considered pathological at altitude.

Providing preventive advice

Gradual ascent remains the most effective approach to preventing altitude illness. The Himalayan Rescue Association conservatively recommends ascending no more than 300 m per day above 3000 m, with a rest day every 600–900 m. The Wilderness Medical Society guidelines suggest a rest day every 3–4 days, with a maximum daily ascent of 500 m. Some travellers who observe these recommendations will still develop AMS, but it is more likely to be mild and not progress to HACE. In addition to gradual ascent, patients can be advised that avoidance of strenuous exercise, keeping well hydrated, eating a high-carbohydrate diet, not trekking with upper respiratory tract infections, and avoiding sedative-hypnotic drugs or alcohol, are also effective measures to prevent AMS. Physically fitter individuals are not protected against altitude illness, and should be counselled about not having a false sense of security in ascending rapidly.[2] The Wilderness Medical Society has devised a useful classification system for AMS into low-, moderate-, and high-risk categories based on past history of altitude illness and rate of gain in sleeping altitude, and this informs decisions about using chemoprophylaxis.[4]

Table 1. Dosage recommendations for chemoprophylaxis at altitude[2]

Medication	Adult dosage	Advice
AMS/HACE		
Acetazolamide	125 mg orally twice daily	Start 1 day before ascent and continue for 2 days at highest sleeping altitude
Dexamethasone	4 mg orally every 12 hours (passive ascent) 4 mg orally every 6 hours (active ascent)	Start on day of ascent and continue for 2–3 days at highest sleeping altitude; do not use for >10 days
Acetazolamide plus dexamethasone	Same doses as for individual use	Same doses as for individual use
HAPE		
Nifedipine	60 mg (slow release) orally in 2–3 divided doses daily[a]	Start 1 day before ascent and stop after 5 days at highest sleeping altitude
Salmeterol	125 µg inhaled twice daily	Use only with nifedipine in very high-risk individuals; start and stop both drugs together

[a] *Nifedipine 20 mg dose available in Europe; 30 mg dose available in the US. AMS = acute mountain sickness. HACE = high altitude cerebal edema. HAPE = high-altitude pulmonary edema.*

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Chemoprophylaxis

Patients should be reminded that prophylactic medication does not always prevent AMS, but is likely to limit the severity of its symptoms. Prophylactic medication with acetazolamide which produces a metabolic acidosis and hyperventilation, is only recommended for moderate- or high-risk individuals, including those with a history of HACE or HAPE (Table 1). Travellers at high risk of altitude illness have a history of AMS on ascending to ≥2800 m in 1 day, a previous history of HAPE or HACE, will be ascending to >3500 m in 1 day without a history of AMS, or are embarking on a very rapid ascent (for example, Mount Kilimanjaro). Acetazolamide prophylaxis is recommended for the very rapid ascent rate on Mount Kilimanjaro, although a recent study concluded that this drug was ineffective in preventing AMS along the popular Marango route, which takes 4–5 days to complete.[5] The cost of hiring guides and the daily National Park fee are factors that influence the ascent rates of commercial treks on this mountain. Pre-acclimatisation on a nearby peak such as Mount Meru, or trekking on the longer Lemosho route, are safer options for travellers. Patients with sulfa drug allergies should take a test dose of acetazolamide prior to travel.

Dexamethasone is effective at preventing AMS but may cause a rebound effect upon discontinuing the drug because it masks symptoms. Ibuprofen may reduce the incidence of AMS, but the evidence for using the antioxidant *Gingko biloba* is less convincing. Some individuals, including those with a reduced pulmonary vascular bed or pre-existing pulmonary hypertension, are particularly susceptible to HAPE. Only patients who have been diagnosed with HAPE previously should use nifedipine for prophylaxis and are advised not to ascend to the altitude at which HAPE developed; salmeterol may be supplemented in very high-risk cases. Acetazolamide can be taken at a dose of 125 mg at 1 hour before bedtime at night to reduce periodic breathing and improve sleep quality.[2]

Management of high-altitude illness

Immediate descent, where feasible, may be supplemented by the use of medications in patients with severe AMS or HACE (acetazolamide, dexamethasone), and HAPE (nifedipine). A portable hyperbaric chamber, although infrequently available to commercial trekkers, is a valuable adjunct to descent, especially where delays occur in mobilising porters and guides.[6] When fully pressurised, the effective ambient pressure inside the chamber simulates descent; the higher the altitude, the greater the simulated descent. It is generally accepted that AMS, HAPE, and HACE require approximately 2 hours, 4 hours, and 6 hours of chamber pressurisation, respectively.

Pre-existing medical conditions

Table 2 summarises the principal considerations in patients with chronic cardiac or respiratory illnesses who wish to travel to altitude. These patients may require specialist evaluation before embarking on travel at high-altitude. Few absolute contraindications to travel at high-altitude exist, and these include severe pulmonary hypertension, decompensated heart failure, obstructive sleep apnoea, and sickle cell anaemia.[7]

CONCLUSION

GPs have an important role in counselling patients about the physiological effects of altitude, safe ascent profiles, recognition and management of AMS, HACE, and HAPE, and their prevention through gradual ascent and the use of chemoprophylaxis in selected cases, based on previous altitude history and proposed sleeping altitude. Furthermore, we suggest that the GP has an important public health role in advocating for the greater provision of portable hyperbaric chambers by commercial trekking companies in remote high-altitude environments. The GP should also recommend patients purchase travel medical insurance covering helicopter evacuation and repatriation before planning travel at high altitude.

Table 2. Precautions at altitude for patients with cardiorespiratory conditions[7]

Condition	Recommendations
Cardiovascular	
Coronary heart disease	Limit activity in patients with stable angina; no altitude travel for 6 months after acute coronary syndrome
Congenital heart disease	More susceptible to HAPE; contraindicated if symptomatic pulmonary hypertension at sea level
Heart failure	Contraindicated if symptomatic at resident altitude; consider use of acetazolamide
Hypertension	Slight increase in blood pressure; pathological large increase in some individuals; favour alpha-adrenergic blockers and nifedipine for improved control; caution with diuretics and beta-blockers at altitude
Stroke	Increased risk of ischaemic stroke due to hyperviscosity; no altitude travel for 3 months post-stroke or transient ischaemic attack
Respiratory	
Asthma	Decreased allergens and reduced resistance may benefit some patients with asthma at 3500–5000 m; increased risk at 2000–3500 m; protect mouth from cold; use volumetric spacers for metered dose inhalers
COPD	Chronic hypercapnia may blunt hypoxic ventilatory response; contraindicated for patients with dyspnoea at rest or on mild exertion at sea level
Interstitial lung disease	May require echocardiography to assess for pulmonary hypertension; consider nifedipine prophylaxis
Obstructive sleep apnoea	Increased risk of HAPE; contraindicated if hypoxic at sea level; acetazolamide is indicated; CPAP device may require pressure setting adjustment
Pneumothorax	No air travel or other altitude ascent until 2 weeks following resolution

COPD = chronic obstructive pulmonary disease. CPAP = continuous positive airway pressure. HAPE = high-altitude pulmonary edema.